

PATENT ABSTRACTS OF JAPAN

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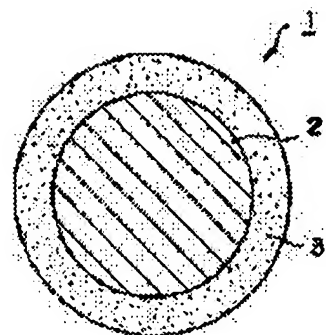
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(54) COMPOSITE POWDER FOR THERMAL SPRAYING

(57)Abstract:

PURPOSE: To produce composite powder for thermal spraying capable of forming sprayed film excellent in thermal impact resistance, wear resistance and adhesion by coating the surface of Ti powder with an Ni layer.

CONSTITUTION: The surface of Ti powder 2 is coated with an Ni layer 3 to obtain composite powder 1 for thermal spraying. At this time, the average grain size of the composite powder 1 for thermal spraying is preferably regulated to 10 to 150 μ m, particularly to about 40 to 70 μ m. Moreover, the thickness of the coated Ni layer 3 is preferably regulated to $\geq 5\mu$ m and the ratio of the grain size of the Ti powder: the thickness of the Ni layer to $\leq 10:1$. This composite powder can be obt'd. by subjecting the Ti powder having about 20 to 100 μ m average grain size and the Ni powder having about 0.1 to 10 μ m average grain size to mechanical plating.



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TITLE: COMPOSITE POWDER FOR THERMAL SPRAYING

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APPL-NO: JP07083373

APPL-DATE: March 15, 1995

INT-CL (IPC): C23C004/06

ABSTRACT:

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DERWENT-ACC-NO: 1996-493661

DERWENT-WEEK: 199649

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TITLE: Composite powder for flame coating giving improved thermal impact resistance - comprising **nickel@-coated titanium@ powder with specified particle size and nickel@ layer** thickness

PATENT-ASSIGNEE: MITSUBISHI MATERIALS CORP[MITV]

PRIORITY-DATA: 1995JP-0083373 (March 15, 1995)

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ABSTRACTED-PUB-NO: JP 08253851A

BASIC-ABSTRACT:

The surface of **Ti powder is coated with a Ni layer**. Average particle size of the composite powder is 10-150 μ m. Thickness of the Ni layer is more than 5 μ m. **Ti powder particle size to Ni layer** thickness is less than 10:1.

ADVANTAGE - Thermal impact, abrasion resistance and adhesion are increased.

CHOSEN-DRAWING: Dwg. 1/3

TITLE-TERMS: COMPOSITE POWDER FLAME COATING IMPROVE THERMAL IMPACT RESISTANCE

COMPRISE **NICKEL@ COATING TITANIUM@ POWDER SPECIFIED PARTICLE SIZE**
NICKEL@ LAYER THICK

DERWENT-CLASS: M13 M22

CPI-CODES: M13-C; M22-H03F;

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CLAIMS

[Claim(s)]

[Claim 1] The end for thermal spraying of composite powder it is characterized by coming to cover the front face of Ti powder with nickel layer.

[Claim 2] The end for thermal spraying of composite powder which it comes to cover the front face of Ti powder with nickel layer, and is characterized by mean particle diameter being 10-150 micrometers.

[Claim 3] The thickness of nickel layer which covers the front face of unalloyed ti powder is in the end for thermal spraying of composite powder it is characterized by being 5 micrometers or more and being less than [Ti powder particle-size:nickel thickness =10]:1.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]**[0001]**

[Industrial Application] This invention is related in the end of the composite powder for thermal spraying for forming the sprayed coating excellent in thermal shock resistance, abrasion resistance, and adhesion in the face side of the engine valve for inhalation of air especially about the composite powder end for thermal spraying for forming a sprayed coating in the front face of the equipment component which receives impact friction at the same time rapid heating quenching is carried out.

[0002]

[Description of the Prior Art] Generally, since the intermetallic compound is excellent in high temperature strength and elevated-temperature corrosion resistance, it forms an intermetallic-compound coat in the inside or front face of various equipments exposed to a severe ambient atmosphere by approaches, such as thermal spraying, and is aiming at improvement in the use life of various equipments.

[0003] For example, in JP,4-21756,A, 20 - 63% of the weight of aluminum powder is contained, and the approach of forming a TiAl system intermetallic-compound coat is proposed by carrying out thermal spraying of the mixed powder with which the remainder consists of Ti powder.

[0004] Therefore, when it is going to form a NiTi system intermetallic-compound coat, what is necessary's being just to carry out thermal spraying of the mixed powder which consists of Ti powder and nickel powder which blended with the predetermined rate and were mixed is happening to think simply.

[0005] however, like the mixed powder which consists of Ti (specific gravity: 4.5) powder and aluminum (specific gravity: 2.7) powder It is rare to change the mixed ratio by the specific gravity difference during mixed powder conveyance, even if it supplies the mixed powder which consists of comparatively little metal powder of a specific gravity difference to a thermal-spraying nozzle and forms a sprayed coating. Like [although there is little obtained concentration change of Ti and aluminum of a sprayed coating] the mixed powder which consists of nickel (specific gravity: 8.9) powder and Ti (specific gravity: 4.5) powder If the mixed powder which consists of big metal powder of a specific gravity difference is supplied to a thermal-spraying nozzle, while resulting [from a hopper] in a thermal-spraying nozzle, according to a specific gravity difference, a mixed ratio will change and the NiTi system intermetallic-compound coat of a uniform component presentation will not be obtained. Therefore, in order to form the intermetallic-compound coat which consists of a large metal of a specific gravity difference like nickel and Ti by thermal spraying, the NiTi system intermetallic-compound powder which atomized the molten metal beforehand ingoted by the predetermined component presentation, and was obtained is used as thermal-spraying powder, and forming a NiTi system intermetallic-compound sprayed coating is also considered.

[0006]

[Problem(s) to be Solved by the Invention] However, although a NiTi system intermetallic compound is excellent in elevated-temperature corrosion resistance and it has the high degree of hardness From the

place which is inferior in the joining nature between NiTi system intermetallic-compound powder, and the joining nature to a base material front face. The sprayed coating obtained by carrying out thermal spraying of the NiTi system intermetallic-compound powder atomized and obtained tends to exfoliate from a base material. While receiving the thermal shock of rapid heating quenching like the face side of the engine valve for inhalation of air especially, there was a technical problem of a crack arising and exfoliating in the sprayed coating formed in the part which repeats a collision and friction.

[0007]

[Means for Solving the Problem] Then, the thermal shock resistance which does not exfoliate even if it carries out thermal spraying to the part which receives impact friction at the same time this invention person etc. receives the thermal shock of rapid heating quenching like the face side of the engine valve for inhalation of air. If plasma-arc thermal spraying of the end of composite powder it comes to cover the front face of Ti powder with nickel layer is carried out as a result of inquiring that the sprayed coating excellent in abrasion resistance and adhesion should be formed. While passing through the inside of a plasma arc the end of composite powder, a NiTi intermetallic compound generates on the boundary of unalloyed Ti powder and a pure nickel coat. The sprayed coating formed in the base material front face has the organization where Ti particle covered with the NiTi intermetallic-compound layer in nickel base carried out homogeneity distribution. The research result of not exfoliating even if it excels in adhesion and receives a thermal shock and impact friction, since this sprayed coating is using nickel as the junction metal was obtained.

[0008] This invention is made based on this research result, and has the description in the end for thermal spraying which comes to cover the front face of Ti powder with nickel layer of composite powder.

[0009] A mean-particle-diameter:20-100micrometer Ti powder and mean-particle-diameter:0.1-10micrometer nickel powder are mixed to homogeneity with a mixer the composite powder end for thermal spraying of this invention. The obtained mixed powder is inserted in a container, and nickel powder is made to stick to the front face of Ti powder by pressure by making mixed powder agitate with a rabble, and it manufactures by forming nickel layer (the approach of forming nickel layer by this approach is hereafter called mechanical plaiting). The end of composite powder it was obtained by mechanical plaiting is sifted, the composite powder end of a 10-150-micrometer diameter is classified and taken out, and it considers as the composite powder end for thermal spraying of this invention. Having set particle size after [for thermal spraying / composite powder] this invention to 10-150 micrometers. In the particle size of less than 10 micrometers, Ti powder and nickel layer fuse completely in the plasma. Since it becomes impossible to maintain the complex tissue of Ti and nickel, preferably on the other hand. While passing through the short interior of the plasma which the heat capacity in the end for thermal spraying of composite powder was too large, and generated at the tip of a thermal spraying gun when 150 micrometers was exceeded, nickel layer does not fully fuse. Therefore, since the formed sprayed coating does not stick to a substrate, but becomes still more inadequate [generation of a NiTi intermetallic compound] and sufficient abrasion resistance is not obtained, it is because it is not desirable. A much more desirable particle size after [for thermal spraying / composite powder] this invention is 40-70 micrometers.

[0010] nickel layer in the end for thermal spraying of composite powder which consists of Ti powder and nickel layer of this invention is 5 micrometers or more, and is less than [thickness = 10]:1 (much more preferably 5:1) of the particle-size:nickel layer of Ti powder. the thickness of nickel layer -- less than 5 micrometers -- and particle-size [of Ti powder]: -- thickness = 10 **: of nickel layer -- since the amount [in / that it is 1 / a sprayed coating] of nickel is insufficient and the adhesion over a base material runs short, it is not desirable.

[0011] Therefore, as for the thickness of nickel layer in the composite powder end for thermal spraying of this invention, it is desirable to manufacture by the describing [above] mechanical plaiting method from the place which needs to be covered in large quantities thickly, and it becomes [production time] long by the other approaches and is not more efficient than nickel layer formed by approaches, such as the usual plating.

[0012] The configuration and operation in the end for thermal spraying of composite powder of this invention are explained based on a drawing.

[0013] Drawing 1 is a sectional view after [for thermal spraying / composite powder] this invention, and drawing 2 is a cross-section explanatory view in the condition of having supplied the composite powder end for thermal spraying of this invention into the plasma, and having formed the sprayed coating in the base material front face.

[0014] 1 has the structure which covered the front face of the Ti powder 2 with the nickel layer 3 in the end of composite powder for this invention thermal spraying it is shown in drawing 1 . If 1 is supplied into the plasma 6 in this end of composite powder for this invention thermal spraying as shown in drawing 2 , the end for thermal spraying of composite powder the NiTi intermetallic-compound layer 4 was formed in the boundary of the Ti powder 2 and the nickel layer 3, and this NiTi intermetallic-compound layer 4 was formed will collide with a base material 5, and a sprayed coating 7 will be formed. although it will be easy to oxidize if Ti powder exists independently in the atmospheric-air plasma -- the object for this invention thermal spraying -- since it is covered with the nickel layer 3 like end of composite powder 1, Ti powder does not oxidize in a plasma metal spray

[0015] Thus, since the obtained sprayed coating 7 has the organization where the composite particle which covered Ti particle 2a with NiTi intermetallic-compound layer 4a with high hardness carried out homogeneity distribution, it does not exfoliate even if the above-mentioned sprayed coating 7 receives a thermal shock and impact friction from a place excellent in adhesion [as opposed to a substrate in nickel base], and it moreover contains NiTi intermetallic-compound layer 4a in nickel base excellent in ductility, it is excellent also in abrasion resistance.

[0016]

[Example] The unalloyed ti powder and pure nickel powder which have the mean particle diameter shown in Table 1 were prepared, these powder was blended so that it might become the rate shown in Table 1, the mixer was loaded with the obtained combination powder with the diameter:6mm stainless steel ball, after carrying out churning mixing, it took out from the mixer with the stainless steel ball, and mixed powder was produced.

[0017] It agitated so that the well-closed container made from stainless steel might be further loaded with the obtained mixed powder, it might be ground and might be crushed, and nickel layer was covered on Ti powder front face, and 1-10 were produced in the end (henceforth the end of this invention composite powder) of composite powder for this invention thermal spraying it has the mean particle diameter and nickel thickness of Ti which classify the end of composite powder it was obtained, and are shown in Table 1.

[0018] The engine valve made from Ti alloy which consists of Ti-6%aluminum-4%V was prepared, 1-10 were used for the face side of this engine valve made from Ti alloy in the above-mentioned end of this invention composite powder, the atmospheric-air plasma metal spray was performed on condition that the following, and the thickness:100micrometer sprayed coating was formed.

[0019] atmospheric-air plasma metal spray condition plasma gas: -- Ar gas and plasma gas flow rate:1.1x10-3m3 -- /sec., current:400A, electrical-potential-difference:80V, spray rate:0.5gr/sec., carrier gas flow rate:5.7x10-5m3/sec., spray distance:100mm, and face side passing speed:500mm/sec.

[0020] The front face of the sprayed coating formed in the end of this invention composite powder using 1 is polished, and the sketching Fig. of an organization observed with the metaloscope is shown in drawing 3 . It turns out that the sprayed coating formed in the end of this invention composite powder using 1 has the organization which Ti particle 2a covered with NiTi intermetallic-compound layer 4a in nickel base 3a distributed to homogeneity so that clearly also from the sketching Fig. of drawing 3 .

[0021] The engine valve made from Ti alloy which has the sprayed coating obtained by carrying out thermal spraying of 1-10 in the end of this invention composite powder was incorporated as a bulb for inhalation of air of a 2000 cc gasoline engine, and the engine was operated on the conditions of number of rotations:7500r.p.m. operation-time:100 hours. the ratio of the sprayed coating which the sprayed coating of the face side of the engine valve made from Ti alloy received the thermal shock by the repeat of 25 degrees C and 950-degree C cooling heating at this time, and the sprayed coating of a face side has

received a valve seat and impact friction further, took out the engine valve after operation termination of 100 hours, and was formed in the engine valve face side -- abrasion loss and the existence of exfoliation were observed and that result was shown in Table 1.

[0022] the former furthermore ingoted, atomized and obtained for the comparison so that nickel:Ti=1:1 might become comparatively -- atomization powder -- conditions same as the above -- the face side of the above-mentioned engine valve made from Ti alloy -- thermal spraying -- carrying out -- the same -- carrying out -- as the bulb for inhalation of air of a 2000 cc gasoline engine -- incorporating -- the ratio of the sprayed coating of after operation termination of 100 hours, and a face side -- abrasion loss and the existence of exfoliation were observed and the result was shown in Table 1.

[0023]

[Table 1]

種 別	原 料 粉 末		配 合 割 合	複 合 粉 末 の 構 成			溶 射 皮 膜		
	純Ti粉末 の平均粒径 (μm)	純Ni粉末 の平均粒径 (μm)		純Ti粉末:純 Ni粉末	Tiの平均 粒径 (μm)	Ni層厚 (μm)	複合粉末の 平均粒径 (μm)	比 摩 耗 量 $(\times 10^{-3} \frac{\text{mm}^3}{\text{kg}})$	剥離の有無
本 発 明 の 複 合 粉 末	1	40.8	3.1	5:1	47.5	5.0	57.5	6.5	なし
	2	50.1	4.2	3:1	51.3	5.9	63.1	7.9	"
	3	63.2	3.1	2:1	52.9	7.2	67.3	8.9	"
	4	70.6	4.2	2:1	63.9	6.0	75.9	9.2	"
	5	22.2	0.2	10:1	22.2	5.1	32.4	9.0	"
	6	28.3	0.5	5:1	23.8	5.0	33.8	7.1	"
	7	33.4	1.2	2:1	24.1	5.8	35.7	8.8	"
	8	79.2	6.3	10:1	71.3	5.9	83.1	9.6	"
	9	86.6	6.3	10:1	76.8	5.7	88.2	9.2	"
	10	98.9	9.8	10:1	87.1	6.2	99.5	9.1	"
従来複合 粉末	NiTiの溶製アトマイズ粉末						189.6	あり	

[0024]

[Effect of the Invention] exfoliating, even if the sprayed coating obtained from the result shown in Table 1 by carrying out thermal spraying of 1-10 in the end of this invention composite powder receives the thermal shock of long duration, and impact friction -- there is nothing -- a ratio -- a place with little abrasion loss shows excelling also in abrasion resistance.

[0025] As mentioned above, the sprayed coating excellent in thermal shock resistance, abrasion resistance, and adhesion can be formed the composite powder end for thermal spraying of this invention, and the effectiveness which was excellent on industry is brought about.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is a sectional view after [for thermal spraying / composite powder] this invention.

[Drawing 2] It is the cross-section explanatory view showing the behavior of the composite powder end when carrying out the plasma metal spray of the composite powder end for thermal spraying of this invention.

[Drawing 3] It is the organization sketching Fig. of the sprayed coating formed using the composite powder end for thermal spraying of this invention.

[Description of Notations]

1 The End for this Invention Thermal Spraying of Composite Powder

2 Ti Powder

3 Nickel Layer

4 NiTi Intermetallic-Compound Layer

5 Base Material

6 Plasma

7 Sprayed Coating

2a Ti particle

4a NiTi intermetallic-compound layer

[Translation done.]

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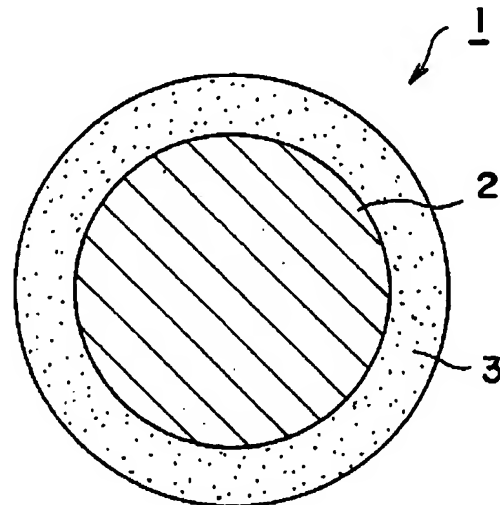
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(54) 【発明の名称】 溶射用複合粉末

(57) 【要約】

【目的】 耐熱衝撃性、耐摩耗性および密着性に優れた溶射皮膜を形成するための溶射用複合粉末を提供する。

【構成】 Ti粉末2の表面にNi層3を被覆してなる平均粒径: 10~150 μ mの溶射用複合粉末であって、Ni層3の厚さは5 μ m以上であり、かつTi粉末粒径: Ni層厚の比が10以下: 1である。



【特許請求の範囲】

【請求項1】 Ti粉末の表面をNi層で被覆してなることを特徴とする溶射用複合粉末。

【請求項2】 Ti粉末の表面をNi層で被覆してなり、平均粒径が10～150 μ mであることを特徴とする溶射用複合粉末。

【請求項3】 純Ti粉末の表面を被覆するNi層の厚さは5 μ m以上であり、かつTi粉末粒径：Ni層厚＝10以下：1であることを特徴とする溶射用複合粉末。

【発明の詳細な説明】

【0001】

【産業上の利用分野】この発明は、急熱急冷されると同時に衝撃摩擦を受ける装置部品の表面に溶射皮膜を形成するための溶射用複合粉末に関し、特に吸気用エンジンバルブのフェース面に耐熱衝撃性、耐摩耗性および密着性に優れた溶射皮膜を形成するための溶射用複合粉末に関するものである。

【0002】

【従来の技術】一般に、金属間化合物は高温強度および高温耐食性に優れているために、過酷な雰囲気さらされる各種装置の内面または表面に溶射等の方法により金属間化合物皮膜を形成し、各種装置の使用寿命の向上を図っている。

【0003】例えば、特開平4-21756号公報では20～63重量%のAl粉末を含有し、残りがTi粉末からなる混合粉末を溶射することによりTiAl系金属間化合物皮膜を形成する方法が提案されている。

【0004】したがって、NiTi系金属間化合物皮膜を形成しようとする場合には、所定割合に配合し混合されたTi粉末およびNi粉末からなる混合粉末を溶射すればよいことは簡単に思い付くことである。

【0005】しかし、Ti（比重：4.5）粉末およびAl（比重：2.7）粉末からなる混合粉末のように、比重差の比較的小さい金属粉末からなる混合粉末を溶射ノズルに供給して溶射皮膜を形成しても混合粉末搬送中に比重差による混合比率が変動することは少なく、得られた溶射皮膜のTiとAlの濃度変化は少ないが、Ni（比重：8.9）粉末およびTi（比重：4.5）粉末からなる混合粉末のように、比重差の大きな金属粉末からなる混合粉末を溶射ノズルに供給すると、ホッパーから溶射ノズルに至る間に比重差によって混合比率が変化し、均一な成分組成のNiTi系金属間化合物皮膜は得られない。そのために、NiとTiのような比重差の大きい金属からなる金属間化合物皮膜を溶射により形成するには、あらかじめ所定の成分組成に溶製された溶湯をアトマイズして得られたNiTi系金属間化合物粉末を溶射粉末として使用し、NiTi系金属間化合物溶射皮膜を形成することも考えられる。

【0006】

【発明が解決しようとする課題】しかし、NiTi系金

属間化合物は高温耐食性に優れてかつ高硬度を有しているが、NiTi系金属間化合物粉末相互の溶着性および基材表面に対する溶着性が劣っているところから、アトマイズして得られたNiTi系金属間化合物粉末を溶射して得られた溶射皮膜は基材から剥離しやすく、特に吸気用エンジンバルブのフェース面のように急熱急冷の熱衝撃を受けると同時に衝突と摩擦を繰り返す部分に形成された溶射皮膜には亀裂が生じ剥離するなどの課題があった。

10 【0007】

【課題を解決するための手段】そこで、本発明者等は、吸気用エンジンバルブのフェース面のような急熱急冷の熱衝撃を受けると同時に衝撃摩擦を受ける個所に溶射しても剥離することのない耐熱衝撃性、耐摩耗性および密着性に優れた溶射皮膜を形成すべく研究を行った結果、Ti粉末の表面をNi層で被覆してなる複合粉末をプラズマアーク溶射すると、複合粉末はプラズマアーク中を通過する間に純Ti粉末と純Ni被膜の境界でNiTi金属間化合物が生成し、基材表面に形成された溶射皮膜はNi素地中にNiTi金属間化合物層で被覆されたTi粒子が均一分散した組織を有し、この溶射皮膜はNiを接合金属としているために密着性に優れ、熱衝撃および衝撃摩擦を受けても剥離することはないという研究結果が得られたのである。

【0008】この発明は、かかる研究結果に基づいてなされたものであって、Ti粉末の表面をNi層で被覆してなる溶射用複合粉末に特徴を有するものである。

【0009】この発明の溶射用複合粉末は、平均粒径：20～100 μ mのTi粉末と平均粒径：0.1～10 μ mのNi粉末を混合器により均一に混合し、得られた混合粉末を容器に装入し、攪拌棒で混合粉末を攪拌させることによりTi粉末の表面にNi粉末を圧着させ、Ni層を形成することにより製造する（以下、この方法によりNi層を形成する方法をメカニカルプレーティングという）。メカニカルプレーティングにより得られた複合粉末をふるいにかけて10～150 μ mの径の複合粉末を分級して取り出し、この発明の溶射用複合粉末とする。この発明の溶射用複合粉末の粒径を10～150 μ mとしたのは、10 μ m未満の粒径ではプラズマ中でTi粉末とNi層が完全に溶融し、TiとNiの複合組織を維持できなくなるので好ましくなく、一方、150 μ mを越えると溶射用複合粉末の熱容量が大きすぎて溶射ガン先端に生成した短いプラズマ内部を通過中にNi層が十分に溶融せず、したがって形成された溶射皮膜が基板に密着せず、さらにNiTi金属間化合物の生成も不十分となるので十分な耐摩耗性が得られないので好ましくないことによるものである。この発明の溶射用複合粉末の層好ましい粒径は40～70 μ mである。

【0010】この発明のTi粉末およびNi層からなる溶射用複合粉末のNi層は5 μ m以上であり、かつTi

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粉末の粒径：Ni層の厚さ＝10以下：1（一層好ましくは5：1）である。Ni層の厚さが5μm未満でかつTi粉末の粒径：Ni層の厚さ＝10超：1であると、溶射皮膜におけるNi量が不足して基材に対する密着性が不足するので好ましくない。

【0011】したがって、この発明の溶射用複合粉末におけるNi層の厚さは通常のメッキなどの方法で形成されるNi層よりも厚く大量に被覆する必要があるところから、上記メカニカルプレーティング法により製造することが好ましく、その他の方法では製造時間が長くなって効率的でない。

【0012】この発明の溶射用複合粉末の構成および作用を図面に基づいて説明する。

【0013】図1は、この発明の溶射用複合粉末の断面図であり、図2は、この発明の溶射用複合粉末をプラズマ中に供給し、基材表面に溶射皮膜を形成した状態の断面説明図である。

【0014】図1に示される本発明溶射用複合粉末1は、Ti粉末2の表面をNi層3で被覆した構造を有している。この本発明溶射用複合粉末1を図2に示されるようにプラズマ6中に供給すると、Ti粉末2とNi層3の境界にNiTi金属間化合物層4が形成され、このNiTi金属間化合物層4が形成された溶射用複合粉末が基材5に衝突して溶射皮膜7が形成される。Ti粉末は大気プラズマ中に単独で存在すると酸化しやすいが、本発明溶射用複合粉末1のようにNi層3で被覆されているのでプラズマ溶射中にTi粉末が酸化することはない。

【0015】このようにして得られた溶射皮膜7は、延性に優れたNi素地中に、Ti粒子2aを硬さの高いNiTi金属間化合物層4aで被覆した複合粒子が均一分散した組織を有し、Ni素地は基板に対する密着性に優れているところから上記溶射皮膜7は熱衝撃および衝撃摩擦を受けても剥離することがなく、しかもNiTi金属間化合物層4aを含むので耐摩耗性にも優れている。

【0016】

【実施例】表1に示される平均粒径を有する純Ti粉末および純Ni粉末を用意し、これら粉末を表1に示される割合となるように配合し、得られた配合粉末を直径：6mmのステンレスボールと共にミキサーに装填し、攪拌混合したのちミキサーからステンレスボールと共に取り出して混合粉末を作製した。

【0017】得られた混合粉末をさらにステンレス鋼製密閉容器に装填し、擦り潰すように攪拌してTi粉末表面にNi層を被覆し、得られた複合粉末を分級して表1に示されるTiの平均粒径およびNi層厚を有する本発

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明溶射用複合粉末（以下、本発明複合粉末という）1～10を作製した。

【0018】Ti-6%Al-4%VからなるTi合金製エンジンバルブを用意し、このTi合金製エンジンバルブのフェース面に上記本発明複合粉末1～10を用いて下記の条件で大気プラズマ溶射を行い、膜厚：100μmの溶射皮膜を形成した。

【0019】大気プラズマ溶射条件

プラズマガス：Arガス、

プラズマガス流量：1.1×10⁻³m³/sec.、

電流：400A、

電圧：80V、

溶射速度：0.5gr/sec.、

キャリアガス流量：5.7×10⁻⁵m³/sec.、

溶射距離：100mm、

フェース面移動速度：500mm/sec.。

【0020】本発明複合粉末1を用いて形成した溶射皮膜の表面を研磨し、金属顕微鏡により観察した組織の写生図を図3に示す。図3の写生図からも明らかなように、本発明複合粉末1を用いて形成した溶射皮膜は、Ni素地3a中にNiTi金属間化合物層4aで被覆されたTi粒子2aが均一に分散した組織を有していることがわかる。

【0021】本発明複合粉末1～10を溶射して得られた溶射皮膜を有するTi合金製エンジンバルブを2000ccのガソリンエンジンの吸気用バルブとして組み込み、

回転数：7500r.p.m.

運転時間：100時間

の条件でエンジンを作動させた。この時Ti合金製エンジンバルブのフェース面の溶射皮膜は25℃と950℃の冷却加熱の繰り返しによる熱衝撃を受け、さらにフェース面の溶射皮膜はバルブシートと衝撃摩擦を受けており、100時間の運転終了後エンジンバルブを取り出してエンジンバルブフェース面に形成された溶射皮膜の比摩耗量および剥離の有無を観察し、その結果を表1に示した。

【0022】さらに比較のために、Ni：Ti＝1：1の割合となるように溶製しアトマイズして得られた従来アトマイズ粉末を上記Ti合金製エンジンバルブのフェース面に溶射し、同様にして2000ccのガソリンエンジンの吸気用バルブとして組み込み、100時間の運転終了後、フェース面の溶射皮膜の比摩耗量および剥離の有無を観察し、その結果を表1に示した。

【0023】

【表1】

種 別	原 料 粉 末		配 合 割 合	複 合 粉 末 の 構 成			溶 射 皮 膜	
	純Ti粉末 の平均粒径 (μm)	純Ni粉末 の平均粒径 (μm)		Tiの平均 粒径 (μm)	Ni層厚 (μm)	複合粉末の 平均粒径 (μm)	比 摩 耗 量 ($\times 10^{-4} \frac{\text{g}}{\text{mm}^2 \cdot \text{h}}$)	剥離の有無
1	40.8	3.1	5:1	47.5	5.0	57.5	6.5	なし
2	50.1	4.2	3:1	51.3	5.9	63.1	7.9	"
3	63.2	3.1	2:1	52.9	7.2	67.3	8.9	"
4	70.6	4.2	2:1	83.9	6.0	75.9	9.2	"
5	22.2	0.2	10:1	22.2	5.1	32.4	9.0	"
6	28.3	0.5	5:1	23.8	5.0	33.8	7.1	"
7	33.4	1.2	2:1	24.1	5.8	35.7	8.8	"
8	79.2	6.3	10:1	71.3	5.9	83.1	9.6	"
9	86.6	6.3	10:1	76.8	5.7	88.2	9.2	"
10	98.9	9.8	10:1	87.1	6.2	99.5	9.1	"
従来複合 粉 末	NiTiの溶型アトマイズ粉末						189.6	あり

【0024】

【発明の効果】表1に示される結果から、本発明複合粉末1～10を溶射して得られた溶射皮膜は、長時間の熱衝撃および衝撃摩擦を受けても剥離することがなく、比摩耗量が少ないところから耐摩耗性にも優れていることがわかる。

【0025】上述のように、この発明の溶射用複合粉末は、耐熱衝撃性、耐摩耗性および密着性に優れた溶射皮膜を形成することができ、産業上すぐれた効果をもたらすものである。

【図面の簡単な説明】

【図1】この発明の溶射用複合粉末の断面図である。

【図2】この発明の溶射用複合粉末をプラズマ溶射する*

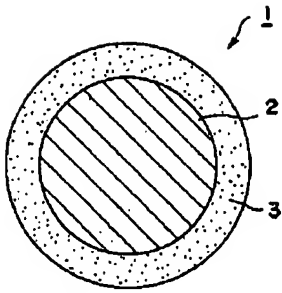
* 時の複合粉末の挙動を示す断面説明図である。

【図3】この発明の溶射用複合粉末を用いて形成した溶射皮膜の組織写真図である。

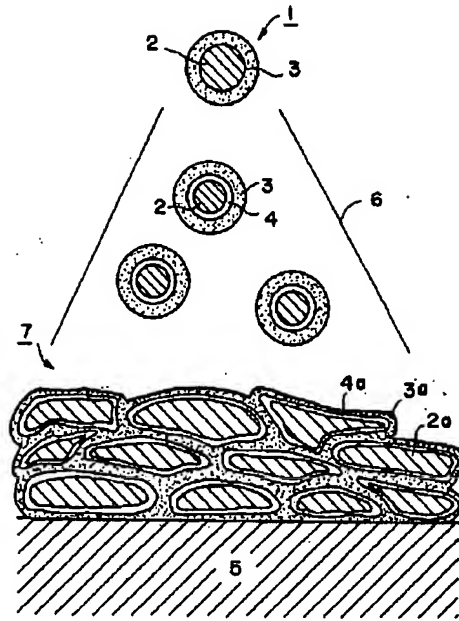
【符号の説明】

- 1 本発明溶射用複合粉末
- 2 Ti粉末
- 3 Ni層
- 4 NiTi金属間化合物層
- 5 基材
- 6 プラズマ
- 7 溶射皮膜
- 2a Ti粒子
- 4a NiTi金属間化合物層

【図1】



【図2】



【図3】

